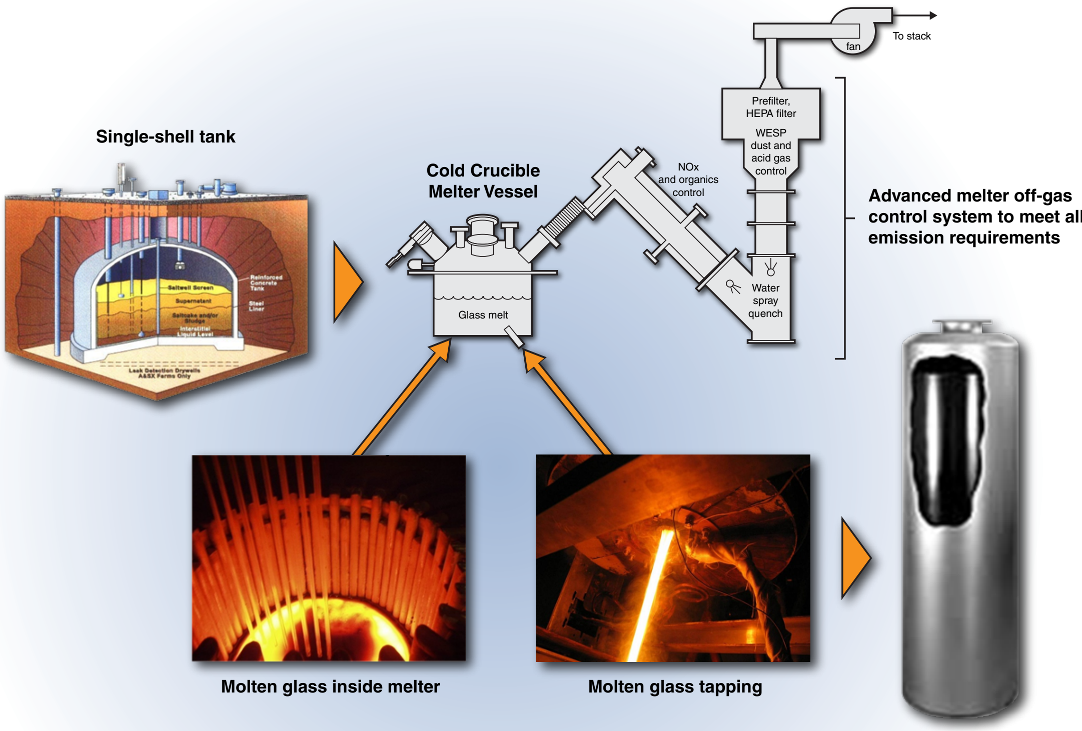


Molten glass inside melter

Molten glass tapping

Solid glass inside canister for disposal

*Cold crucible induction melters can convert highly dangerous liquid radioactive wastes into solidified glass that is safely handled, stored, and disposed of.*

The Energy of Innovation

# Cold Crucible Induction Melting

## *A cool way to make radioactive wastes safe for disposal*

Cold crucible induction melting (CCIM) has the potential to significantly simplify and reduce the cost for stabilizing waste around the world. The technology is now being used to vitrify radioactive wastes in France and Russia, and is being researched for radioactive waste treatment in the U.S., Korea and Taiwan.

Due to the unique way of heating the melter and containing the melt—keeping the hot, hot, and the cold, cold—this melting technology can process radioactive wastes faster, safer and at lower cost than other technologies. Future applications include processing high-purity and corrosive products, like alumina, zirconia, ruby-glasses and custom design specialty glasses at temperatures greater than 1,300 degrees C in a wear-free melter vessel.

### *Test System and Advanced Thermo-electrical Modeling*

INL has the only CCIM prototype in North America in an integrated testbed, also capable of measuring the fate of waste feed components and demonstrating off-gas emissions control. This system tests solid, liquid and slurry feeds with continuous processing. The 60 kW melter can operate over a range of frequencies from 100 KHz to 4 MHz.

### *Design, Operation Theory*

An induction coil surrounds a melter shell constructed of electrically-isolated water-cooled metal tubing. When an electric current passes through the coil, it inductively heats an electrically conductive susceptor inside the melter. The susceptor heats starter glass frit until it becomes molten, when it is also electri-

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cally conductive and inductively heated. New feed is heated by, and melts into, the molten glass. Water-cooling of the crucible tubes freezes a thin layer, or shell, to form inside the melter wall. Thus, the melt can be heated to at least 3,000 degrees C while maintaining the melt in a solid containment shell that isolates the melter from the melt and at the same time, protecting the melt. The induction heating and cold crucible design eliminates the need for electrodes that directly contact the molten glass and refractory used to contain the melt.

### Technology Advantages

- No refractories that can be damaged or corroded,
- No electrodes that corrode at high melt temperatures,
- Self-cleaning – the molten glass does not adhere to the water-cooled walls, enabling easier and more complete melter cleaning and decontamination, and
- High purity – without metals or refractories that interact with the melt, high purity melts are achieved.

### CCIM Thermo-electrical Modeling

INL has established a CCIM thermo-electrical modeling program designed to better understand induction melting technology, optimize CCIM design and operation, provide melter diagnostics, and enable automatic melter control.

### Induction Heating

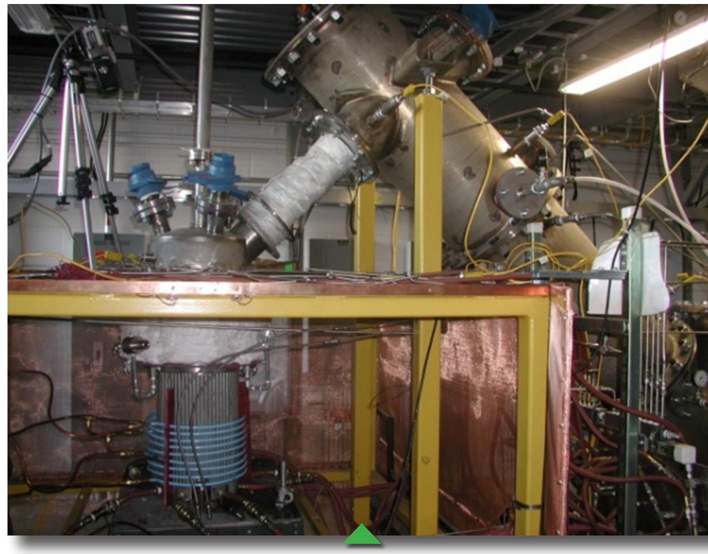
Understanding induction heating helps increase CCIM performance. Most of the induction energy is deposited in an annular ring inside the melt near the wall, defined as the "skin depth"— that depends on the melt resistivity, magnetic permeability, and induction energy frequency. The thickness of the skin depth is a fraction of the melter diameter.

### Finite Element Model

In collaboration with the St. Petersburg State Electrochemical University in Russia, a finite element model has been developed and used to estimate glass melt temperatures where the high temperatures destroy normal temperature sensors. This model predicts melt temperatures that are so hot that they are not easily measured. The model is also being designed to optimize power input by monitoring the input current and voltage, and automatically making frequency adjustments. These technology developments are protected by proprietary INL patents.

### New Test Data

CCIM tests recently performed for AREVA Federal Services demonstrated that radioactive waste simulants can be safely vitrified at higher feedrates, higher waste loadings, and higher temperatures than can be achieved by current vitrification technology in the U.S. The tests also showed how feed constituents such as Cesium can be retained in the glass melt. The results indicate that treatment of legacy wastes can be accelerated and treatment costs reduced. CCIM technology can also be a key future component in expanded nuclear power in the U.S.



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### For more information

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